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# LONDON TRANSPORT BUSES: ATT IN ACTION AND THE LONDON COUNTDOWN ROUTE 18 PROJECT

Richard Smith, London Transport Buses,
Stephen Atkins, London Transport Planning,
and Robert Sheldon, Accent Marketing and Research.

London Transport, 55 Broadway, London SW1H 0BD
Accent Marketing and Research, 14-16 Turnham Green Terrace,
Chiswick, London W4 1QP

## ABSTRACT

This paper considers the application of ATT to bus operations in London. In particular the Countdown dynamic, real-time passenger information at bus stops project is described and the results of the monitoring study to evaluate system performance and passenger reaction are reviewed.

## 1. INTRODUCTION

London Transport Buses' operations effectively cover the Greater London area, some 1500 square kilometres almost all of which is densely developed. This includes the core areas of the City of London and Westminster with their own acute transport problems. However Greater London is in practice many inter-locking town centres all of which are long established and have very limited road capacity. Congestion and consequent delays are endemic throughout London and not just during peak hours. In many parts of London highways are congested throughout the day. It is in this environment that London Transport Buses must provide for more than 3½ million passengers every day.

London Transport Buses is keen to exploit the benefits of ATT. This is evidenced by the numerous experiments to introduce ATT over the past three decades, many of which were the pioneers of systems now being brought into wider implementation. However ATT cannot be a solution in itself and London Transport Buses' approach is to use ATT to complement other measures being taken to improve bus services in London.

As the technology for ATT has developed and matured so too have the applications of it in London. The key objectives in using ATT are first to improve service reliability by providing management with improved service control and by facilitating priority for buses at traffic signals to reduce delays and irregularity. Secondly, ATT is being used to provide passengers with real

time information on the state of the services they are using. When investing in new systems it is vital to ensure that these systems represent good value for money and that they maximise the benefits from inevitably limited financial resources.

In the late 1980s trials of Selective Vehicle Detection (SVD), giving buses limited priority at traffic signals demonstrated the substantial benefits achievable at low cost and with little effect on other traffic. Trials in the same period showed that real time information could be provided effectively and reliably on the state of the bus service. Subsequent work has built upon these trials.

The SVD project has been extended London-wide to over 300 junctions with some 3,700 buses equipped to obtain priority. With the help of European Community DRIVE II funding in the PROMPT project this principle is being developed for implementation within linked UTC systems. In London this will operate within the SCOOT signal control programmes and trials are currently being implemented in two areas. On London's congested road network if substantial disbenefits to other traffic is to be avoided it is only practicable to give very small benefits to each bus, but the large numbers of buses means substantial benefits are predicted.

The remainder of this paper describes the Countdown project on route 18 and the monitoring being undertaken. Countdown has been widely welcomed by passengers and is already being extended to further routes to establish the benefits achievable from wider implementation.

## 2. COUNTDOWN

In 1990, as part of a programme to improve bus service quality, a demonstration trial of Passenger Information at Bus Stops (PIBS) was authorised for Route 18. Following a tender competition, a contract was let in 1991 to the SEREL Company (now SLE) of Nice, France for both hardware and software for a PIBS/AVL system. Passenger information is provided to bus stop signs utilising an automatic vehicle location (AVL) system that also supplies the bus operating company with information to facilitate operational control of buses serving the route.

Signs for the PIBS system, marketed as "Countdown", were installed in Autumn 1992. System testing and development continued until March 1993, at which time all "testing" signs were removed and the system was considered to be fully operational. An extensive monitoring programme was established including enhancements to LT's regular surveys of service quality and passenger trips, together with a specially commissioned series of studies undertaken by outside consultants. Accent Marketing and Research won a competitive tender to undertake these studies and also provided some management of the overall monitoring programme. The survey programme has included technical reliability, bus service regularity, bus arrival prediction accuracy, visibility and comprehension of the signs, passenger behaviour at bus stops, passenger attitudes, passenger valuation of Countdown information and patronage and revenue studies.

### 2.1 System Description

Route 18 is operated by CentreWest, a west London bus operator, and runs between central and west London using double-deck one person operated buses. At the beginning of each bus journey, the driver registers the bus trip using a keypad in the driving cab; this information is sent to a central computer over the London Transport Buses radio system. As the bus travels along the route, microwave transmissions by roadside beacons are recognised by an on-bus receiver. Approximately every 30 seconds a group call over the radio system returns to the central computer the location data for every registered bus based on beacon message identification and the number of wheel revolutions since passing the last beacon. Thus the location of each bus serving Route 18 is known very frequently to a high degree of precision.

By reference to a database structure and a predictive algorithm that uses the journey times of previous buses on each network link, estimates are made of the time to arrival at bus stops equipped with displays within a 20 minute time horizon. These forecasts are transmitted to the stops over dedicated landlines and are shown on a 24 character per line, 3-line dot matrix display screen of light emitting diodes (LED).

Forecasts are updated after every polling cycle but the signs also count down in real time between forecasts. Originally on Route 18 up to three bus arrivals were shown with the second line scrolling between second and third arrivals. Now up to nine buses on different routes can be shown and signs can incorporate 3 or 4 line displays. A bottom line text message gives the possibility to present further information about bus services including regular, specific or timely messages (eg Route 36 buses also use this stop; No more Route 18 buses tonight; Traffic congestion in Wembley is affecting Route 18 buses today). Fifty stops (of 124 in total on Route 18) are equipped with Countdown displays; these stops cover some 7.5 million (70%) annual passenger boardings along the route.

A workstation at the bus operating centre at Westbourne Park Garage provides service controllers with positional information on buses; communication with bus drivers via Band III radio allows changes to services to be made. Service controllers can also review and control sign displays and compose bottom line text messages to be shown at one or several bus stops.

## 3. MONITORING STUDIES

### 3.1 Component Reliability and System Availability

System components include the roadside beacons, bus transponders and modems, the radio system, computers, land lines and signs. Mean time between failures for each component item is logged. The cumulative effect of individual component failures is overall system availability. The level of failures is generally low and excluding periods of system development, availability has been recorded at over 99%. Vandalism of the signs has been negligible.

### 3.2 Information Accuracy

Countdown accuracy is measured as the time during which the prediction shown on the sign is correct to within a specified accuracy. Cleardown is the removal of a bus from the sign display; this should occur while the bus is at the stop. Cleardown accuracy is measured as the percentage of Cleardowns occurring within specified margins of bus presence at the stop.

In a July 1993 on-street survey of 1379 Countdowns, accuracy was within plus or minus one minute for 50% of the time, within plus or minus two minutes for 75% of the time and within plus or minus five minutes for 96% of the time. For Cleardowns, 66% occurred within plus or minus 30 seconds of bus presence at the stop, 81% within plus or minus one minute and 92% within plus or minus two minutes. More recently, in April 1994, improvements of up to five percentage points on these figures were recorded.

Prediction accuracy reflects system integrity, the quality of the prediction algorithm and the consistency (or inconsistency) of bus journey times which is affected both by operational matters and traffic congestion. Although prediction accuracy as revealed by the surveys is still not as good as London Transport Buses would like, passenger opinion of the accuracy of information was good (see later section) with high levels of satisfaction being recorded.

### 3.3 Route 18 Service Reliability

The AVL system provides the capability for improved operational control of the bus service. If service quality was improved, increasing reliability and reducing average waiting times, then passenger numbers would be expected to increase. In order to be able to distinguish this effect from the effect of Countdown signs, bus service reliability was closely monitored.

London-wide service quality became worse over the period in question; on Route 18 a lesser decline was recorded. The systemwide context was the implementation of changes in conditions of service for bus operating staff, resulting in industrial action and reduced morale, together with continuing security alerts. The local context was one in which roadworks were prevalent along the route, notably at the North Circular Road involving additional traffic signals and extra journey distance for buses on temporary diversions.

It cannot be deduced from these results that AVL has been ineffective in improving service control; without AVL, service quality might have been much worse. It is clear, however, that there has been no improvement in bus service reliability on Route 18 which would have attracted increased patronage and which could, in turn, have confounded other results in the monitoring study. Any changes in patronage, revenue and passenger perceptions therefore can be attributed to Countdown and not to changes in service quality.

### 3.4 Ergonomics

This section covers issues concerning the information content of the displays, the way in which the information is presented (including character size and location of the sign) and interpretation of the sign by passengers including features such as visibility and comprehension. These were investigated in a number of the surveys including direct observation of passengers at bus stops by trained observers, video surveys of passenger behaviour at bus stops and

interviews with passengers.

About 70 percent of people look at the display when first approaching the stop, but a significant minority do not. Some passengers approaching from the "upstream" side wait near the bus stop flag post and therefore cannot see the sign; a proportion of these perceive the bus to be arriving soon and hence do not need to view the information. Some passengers proceed to sit immediately beneath the sign and hence cannot see the display. Nonetheless about 90 percent do observe the sign at least once during their waiting time. About 60 percent of passengers say they view the sign at least once per minute and 40 percent view it almost constantly. Elderly people and non-regular passengers looked at the sign least often. The sign is located close to the underside of the shelter and the sign case is painted in a similar colour to the rest of the shelter. One recommendation of the studies was that the sign should be given greater visual prominence and a poster has now been affixed to the back of the display box directing the passenger to view the reverse side.

Visibility of the sign was very good with over 96% of survey respondents declaring they had no problems in reading the displays. The character size and display brightness were favourably regarded. It is known that persons with certain eyesight difficulties prefer yellow on black displays and a yellow LED sign is currently being trialled.

Passenger comprehension of the information content of the display was very good. Overall there was very strong support for display of three crucial elements: route number, destination and the time to bus arrival, progressively counting down. Some criticisms were made of certain aspects of the sign format. Use of "m" as an abbreviation for minutes was criticised and the removal of the minutes indication when the Countdown becomes zero was clearly subject to some misinterpretation.

### 3.5 Passenger Behaviour at Bus Stops

At a conventional bus stop without a Countdown display a characteristic of people's behaviour is their frequent glances up the route to see if the bus is approaching. Even when engaged in other activities, such as reading a newspaper or holding a conversation, there is a tendency to keep looking to see if the bus is coming. As their wait is extended they become more aware of the passage of time and show more signs of impatience and perhaps frustration. This anxiety is stressful and contributes to the dislike of waiting that is reflected in the traditional weighting of wait time in transport modelling at twice the in-vehicle time. On occasions, if a prospective passenger feels that they have been waiting for an excessive time they may leave the stop and take alternative action, such as using another mode or even abandoning the trip; often it has been observed that the bus arrives shortly after they have left the stop.

Video surveys of passenger behaviour at Countdown stops show behaviour and body language that suggests much reduced levels of stress, confirming the findings of passenger interview studies reported later. For example, people have been observed waiting calmly for the second bus to arrive when the first Route 18 bus did not serve their destination. Generally people glance at the sign periodically and appear reassured, as the Countdown reduces, that the bus is on its way and will arrive at or about the time indicated.

At Countdown equipped stops two particular kinds of passenger behaviour are of special interest. Firstly there is diversionary behaviour where an

intending passenger uses the information on predicted bus arrival to undertake another task, such as making a purchase in a nearby shop, returning to the stop in time to catch the service they require. Diversionary activity will only occur when appropriate opportunities are available close to the bus stop and when passengers have confidence in the accuracy of the predictions to within a reasonable tolerance. Secondly there is opt-out behaviour where potential passengers see that a long wait is predicted and decide not to wait. This latter event may be counteracted by some people approaching the stop intending to walk, but seeing that the bus will be arriving shortly, wait for the bus instead.

### 3.6 Passenger Perceptions and Attitudes

Short bus stop interviews were held before and after Countdown introduction; extended interviews with intending passengers ("hall tests") were conducted covering a number of issues in July 1993.

There was very strong support for the Countdown system with over 90 percent of respondents agreeing that "bus passengers deserve Countdown" and that "Countdown system should be introduced on all bus routes in London". The perceived accuracy of the sign displays was good with 82 percent of the respondents saying that the accuracy was acceptable. Forty five percent felt the accuracy was improving as indeed recent data confirms.

Most passengers (65%) felt that they now waited for a shorter time than before the Countdown displays were introduced; 83% of respondents agreed that if you know when the bus is coming the time seems to pass more quickly and 89% agreed that the display made the waiting time more acceptable. The (average) perceived waiting time dropped from 11.9 minutes to 8.6 minutes between the before and after surveys despite there being no significant change in either the headway or reliability.

There were similar positive views about service reliability with 64% of respondents believing that reliability had improved since Countdown was introduced. As noted earlier, reliability was in fact marginally worse than previously at the time these surveys were conducted.

Sixty eight percent of respondents stated that their general attitude towards bus travel had improved and similar figures for the particular bus operator (CentreWest) and London Transport were 54% and 45% respectively. Such changes in public opinion are not easily manufactured, for example by advertising campaigns.

### 3.7 Passenger Valuation of Countdown

One of the principal criteria for London Transport Buses investment appraisal is passenger benefit, assessed as passengers' willingness to pay for service improvements. For this project there was particular interest in assessment of passenger valuation of the new facility, as values would be influential in determining the extent to which Countdown passenger information should be provided throughout London.

The main methodology adopted for this part of the study was the stated preference technique. In the "hall test" respondents were sat alongside the interviewer in front of a portable personal computer which displayed the questions and, where appropriate, response categories. Questions covered specific details of the current or a recent journey, alternative modes and routes, waiting times experienced and anticipated as well as the attitudinal

questions and sign comprehension tests already discussed earlier. The perceived journey times and costs were used to frame the options for the stated preference exercise; a "customised" approach. Four journey attributes were included: journey time (3 levels), journey cost (3 levels), the presence of a bus conductor (2 levels) and passenger information (3 levels including "Countdown").

The estimated average passenger valuation for Countdown in the mid 20 pence range with a central value of 26 pence per trip. This was higher than had been anticipated and so the result was scrutinised in a number of ways. First the result was validated by the concurrent finding of a value for passengers' in-vehicle travel time of 160 pence per hour, very close to the figure of 165 pence per hour used by London Transport Buses in bus service planning, a well established and reliable parameter.

Second, a supplementary survey was commissioned using a "transfer price" method in which respondents are directly asked about their willingness to pay through fares increases for the Countdown information. Increases in fares were proposed until the point at which the passenger would no longer "purchase" the Countdown information. Such direct questioning would be expected to produce lower values than stated preference methods, since the requirement to pay is very obvious and respondents might be expected to attempt to lessen the likelihood of fares being raised (policy response bias). However, the average response was a value in excess of 20 pence per trip.

Third, the consultants also carried out a re-examination of previous research into passenger valuation of real-time information. It was noted that in earlier studies a "simple" information system produced lower benefit estimates but a "full information" option, closest to the present sign displays, was valued at 44% of average fare. The Countdown research produced a value of about 53% of average fare.

Finally, since the importance of the passenger valuation for justification of future expenditure was recognised, an independent external audit study was commissioned. This report confirmed that the methods and techniques used by the consultants were appropriate, reaffirmed the interpretation of the results at a level in the mid-20s pence range and confirmed that this was a valid conclusion from the studies undertaken.

### 3.8 Patronage and Revenue Generation

A second major objective of the monitoring study programme was to assess whether more passengers were now travelling on Route 18. On-bus revenue receipts and pass use (travelcards, bus passes and concessionary passes) were abstracted from normal ticket machine data collection procedures. In order to compare the results for Route 18 against background trends, two sets of control data were also compiled. One was for all other routes operating from Westbourne Park garage, providing a local area and operator-specific control; the second used data from three routes with similar characteristics: double deck, one person operated, radial routes with minimal overlapping services, operated by other bus companies.

The long-term profile of Route 18 on-bus revenue, represented as a de-seasonalised moving average shows a slight increase in revenue from about the time at which the signs were first installed. However, when on-bus revenue was compared with other routes operating from Westbourne Park, there was no discernable difference between Route 18 and other routes.

Comparison between Route 18 and the second set of control routes shows that Route 18 has performed slightly better by one or two percentage points, however, the other control routes were more affected by industrial action and poor staff morale following the changes in conditions of service for operating staff that were introduced in Spring 1993. In particular drivers in one company specifically stopped recording use of passes, which means that pass use has no effective external control in this study.

Thus although there were some encouraging aspects to the revenue results, the overall conclusion is that at present no additional patronage and revenue generation can be estimated.

## 4. CONCLUSIONS

The Route 18 trial is considered to have been a success. The system is now operating reliably and to accuracies that are judged satisfactory by the majority of passengers. Passenger opinion of the system is very positive and is characterised by an average willingness-to-pay in excess of 20p per trip. This is felt to reflect the considerable reduction in anxiety levels while waiting for the bus, and the opportunity to make positive choices on opt-out or diversionary activities on the basis of reliable information.

Countdown would, on a network basis, add only 1 or 2 pence to the cost of a passenger journey, which means that less than 10% of the passenger benefit would need to be captured through higher fares to fund installation across most routes in London. While the lack of substantive evidence to date of patronage or revenue generation is disappointing, the project still delivers a very impressive social benefit-cost ratio.

Over the coming years ATT is likely to enable bus services in London to be significantly enhanced. London Transport Buses is participating in a number of projects to ensure these associated benefits are achieved. Monitoring is vital to establish that benefits are maximised and that the expenditure represents value for money. The Countdown project described in this paper demonstrates that ATT applications can achieve real and substantial benefits for public transport users and the community at large.